Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

Reviews

The Cause of Earthquakes, Mountain Formation and Kindred Phenomena Connected with the Physics of the Earth. By T. J. J. SEE. *Proc. Am. Phil. Soc.*, Vol. XLV (1907), pp. 274–414.

The typical propositions of this paper are the following:

The dynamical cause of earthquakes and volcanoes probably depends upon the explosive power of steam formed within or just beneath the heated rocks of the earth's crust chiefly by the leakage of the ocean beds. (Pp. 276, 277.)

The internal temperature of the earth is extremely high, with heated rocks quite near the surface, while the crust is fractured and leaky everywhere, and especially where the depth of the sea is greatest. The sea covers three-fourths of the earth's surface, and earthquakes are found to be most violent where the sea is deepest, and volcanoes most numerous on the adjacent shores. Could then anything be more probable than to suppose that both of these great natural phenomena depend simply and wholly upon the explosive power of steam which has developed in the heated rock of the earth's crust? (Pp. 278–80.)

The conclusions are as follows, from which the geologist who has some accurate knowledge of earthquakes, volcanoes, mountains, and geophysics may decide whether he cares to follow up these views in the paper itself:

1. We have seen that deposits of sediment on the continental shelves could not possibly produce anything but the most gradual increase of weight on these portions of the earth's crust; and since such rocks as marble are proved to be fluids of great viscosity, and therefore capable of slow secular bending without rupture, we may feel sure that any stresses thus arising in the earth's crust would be relieved by gradual yielding, and that no violent earthquake shock could ever arise from such a cause.

2. The theory that earthquakes are due to fracture and slipping of rocks is disproved by the great depth (ten to twenty miles) at which world-shaking earthquakes are found to originate, and by virtue of the fact that they come not from a point nor from a line, but from an area; and moreover earthquakes follow the seashore, seldom occurring far inland, and never in desert countries, though abundant in the bed of the ocean.

3. It therefore follows that earthquakes must depend upon explosive forces within or just under the earth's crust, and frequently spread over a considerable area, and the preponderance of disturbances in the sea along the shores of continents shows that the forces depend in some way upon the sea water. These explosive forces can be best studied in connection with the eruption of volcanoes,

since volcanic outbreaks are also accompanied by earthquakes often felt over large areas.

4. Not all earthquakes lead to eruptions, but if the shocks in a given region cease on the eruption of a neighboring volcano, we may feel sure that the forces producing the eruption also produced the antecedent earthquake shocks felt by the surrounding country.

5. That steam is the cause of volcanic eruptions is proved by the distribution of active volcanoes about the seashores and by the innumerable eruptions which occur in the depths of the ocean, whereas such vents always die out inland; and moreover by the fact that of the vapors emitted from volcanoes 999 parts in 1,000 is estimated to be steam, the remaining one-thousandth part being by-products incidental to the moisture and high temperature.

6. The *vera causa* of volcanic action and of certain earthquakes thus established for some particular cases must be held to be the universal cause in all cases whatsoever, according to Newton's rule of philosophy.

7. The heaving of steam accumulating within or just beneath the earth's crust is therefore the true cause of all world-shaking earthquakes, and volcanic outbreaks occur only when an outlet is forced through to the surface, which usually happens in mountains, where the earth's crust is already badly fractured and upheaved.

8. When the subterranean steam pressure becomes great enough to shake the earth's crust, it naturally moves at the nearest fault line, where the rocks are broken, *but the movement observed is the result, not the cause of the earthquake.*

9. Volcanoes are particular mountains blown open by steam pressure under the throes of earthquakes (cracks in the rocks appear to be the beginning of some few volcanoes), and since all volcanoes blow out pumice and ashes, these materials must be held to exist in all mountains, and are made by the inflation of molten rock with steam and other vapors.

10. Any mountain peak, therefore, is capable of becoming a volcano if the subterranean steam pressure be sufficiently powerful to break open an orifice. But orifices close up and volcanoes die out inland and elsewhere if the supply of steam is inadequate to keep open the vents upon which the activity depends. Even if stopped up for a time, later heaving of the earth may give the volcano renewed activity, and when the mountain has been dormant for a long time it is found that the violence of the eruption is greatly increased. The violence of the subterranean pressure in such a case approaches that of a region which has no vent at all, and hence we see why earthquakes in non-volcanic regions frequently become so terrible, because the forces accumulate to frightful fury before any relief whatever is afforded, and the result is a most terrible earthquake.

11. The mountains are formed by the injection of steam-saturated lava under the coast, which breaks the overlying surface rocks and gives rise to a ridge parallel to the sea. This is why all mountains are formed parallel to the seashores.

12. By continually injecting the land with lava from under the bed of the sea the coast is raised and the mountains upheaved, and some of them usually break out into volcanoes; while at the same time the support of the sea bottom is undermined by the thinning-out of the fluid substratum, and at intervals the bottom sinks down to restore stability.

13. The sinking of the sea bottom in this natural process of earthquake injection of the land is the cause of that class of sea waves found to follow violent earthquakes, in which the water first withdraws from the shore and then returns as a huge wave. Those waves noticed to rise suddenly without previous recession of the water usually are due to submarine upheavals and eruptions in the bed of the sea.

14. Islands are built up by injection from the sea, and hence have their mountains as veritable backbones, because the injection is symmetrical from both sides. In many cases the sea bottom is thus undermined and finally sinks down, making a hole beside the island, or a trench. The fact that all islands are not accompanied by such sinks is no argument against the theory, because the subsidence has not always taken place; it is the occurrence of even a considerable number of such sinks beside islands which proves the validity of the theory. Such intimate associations between elevation and depression could not be the result of chance.

15. In the repair of ocean cables broken by earthquakes, subsidence of the sea bottom is frequently found to follow these disturbances. This is a direct observation of the above effects in certain cases which are established by actual measurement, the subsidences frequently amounting to hundreds of fathoms.

16. The sea bottom does not subside without the lava under the crust being forced out into some other place, as into islands, submarine ridges, or shores; none of this movement is due to the secular cooling of the earth, but is all to be explained by the undermining effect of steam accumulating under the earth's crust.

17. Mountains in the interior of a dry country, as the Rocky Mountains in Colorado, exhibit no important movements, while those on the coast, like the Andes, are always heaving. This shows that the sea is the cause, and not the secular cooling of the globe, which is wholly insensible.

18. The only countries which are free from earthquakes are the deserts, and therefore practically uninhabitable; there is accordingly no escape from earthquakes, and buildings designed for permanency should be framed to withstand them without material injury.

19. While in the long run the elevation of the land predominates, there is also subsidence, due to the non-occurrence of the forces in certain regions beneath the crust. It is idle to deny these oscillatory movements of the crust, and many good illustrations of both are clearly established. Every island which is thrown up in the sea is a witness to one of the most general laws of nature.

20. As water is taken up in the crust both in the crystallization of rocks and

in the processes of earthquake movements, and only a part of this vapor is restored to the surface through volcanic action, there is a secular desiccation of the oceans, but the process is excessively slow and not certainly recognizable during the historical period, though a part of the lowering of the strand line in later geological ages is no doubt traceable to this cause.

21. The elevation of the plateaus depends on the same cause which upheaved the mountains; and all plateaus, like the mountains, are underlaid with various forms of pumice, which accounts for their feeble attraction as shown by geodetic observations.

22. No doubt various chemical changes go on under the earth's crust where the water has penetrated the lava and the steam becomes superheated, but the predominance of water vapor in volcanoes shows that the other gases are only by-products, incidental to the moisture and great heat. Dissociation of water vapor is one of these effects.

23. The details of mountain structure admit of explanation on the present hypothesis, while heretofore no such explanation was forthcoming. A theory which accounts for the position of the ranges relatively to the sea, the slopes of the ranges, and the side spurs, and the relation of mountains to earthquakes and volcanic phenomena, should have a strong claim to acceptance. This theory was partially foreshadowed by the Arabian astronomer Avicenna, in the tenth century of our era.

24. The theory of the penetration of sea water into the crust of the earth and its connection with volcanoes and earthquakes dates back to Lucretius and Aristotle, while the upheaval of the land is distinctly announced by Strabo. We have, therefore, been simply verifying and extending the impressions of the ancients formed from the general aspects of nature long before the sciences had become exact. (Pp. 403–7.)

It is only fair to Avicenna, Lucretius, Aristotle, Strabo, and other distinguished authors quoted in this paper, to remark that they are not to be held responsible for all of the assertions of putative fact and physics with which their views are associated in this paper.

T. C. C.

---

1. *Some Additions to the Carboniferous Terrestrial Arthropod Fauna of Illinois.* By A. L. MELANDER. (*Journal of Geology,* Vol. XI, No. 2, February–March, 1903, pp. 178–98, Plates V–VII.)
2. *Some New Structural Characters of Paleozoic Cockroaches.* By E. H. SELLARDS. (*American Journal of Science,* Vol. XV, April, 1903, pp. 307–15, Plates VII, VIII.)
3. *Discovery of Fossil Insects in the Permian of Kansas.* By. E. H. SELLARDS. (*Ibid.,* Vol. XVI, October, 1903, pp. 323–324.)